AMENDMENTS TO THE CLAIMS

The following is a complete, marked up listing of revised claims with a status identifier in parentheses, underlined text indicating insertions, and strikethrough and/or double brackets indicating deletions.

Listing of the Claims

1. (Original) A switching control signal generating circuit comprising:

a pair of input terminals;

a pair of output terminals; and

a conversion circuit which converts differential signals input via the pair of input terminals into differential switching control signals and outputs the differential switching control signals to the pair of output terminals, respectively,

wherein based on a state of each of the differential signals input via the pair of input terminals, the conversion circuit makes a first one of the differential switching control signals having a relatively high level and a second one of the differential switching control signals having a relatively low level transition to the level of the second signal and the level of the first signal, respectively, at different time points.

2. (Original) The circuit as claimed in claim 1, wherein the first signal starts to transition to the second signal before the second signal starts to transition to the first signal.

3. (Original) The circuit as claimed in claim 1, wherein the first signal starts to transition to the second signal after the second signal starts to transition to the first signal.

4. (Original) The circuit as claimed in claim 1, wherein the first and second signals are differential signals.

5. (Original) A switching control signal generating circuit comprising:

a first delay circuit which delays an input signal input to a first input terminal;

a second delay circuit which delays a complementary input signal input to a second input terminal;

a first pull-up circuit which is connected between a first power supply voltage and a first output terminal and pulls up a level of the first output terminal to a level of the first power supply voltage in response to an output signal of the first delay circuit;

a first pull-down circuit which is connected between the first output terminal and a second power supply voltage and pulls down a level of the first output terminal to a level of the second power supply voltage in response to the complementary input signal;

a second pull-up circuit which is connected between the first power supply voltage and a second output terminal and pulls up a level of the second output terminal to the level of the first power supply voltage in response to an output signal of the second delay circuit; and

a second pull-down circuit which is connected between the second output terminal and the second power supply voltage and pulls down a level of the second output terminal to the level of the second power supply voltage in response to the input signal.

6. (Original) The circuit as claimed in claim 5, wherein the output signals of the first and second output terminals are differential signals.

7. (Original) The circuit as claimed in claim 5, wherein the first and second delay circuits are inverters.

8. (Original) A switching control signal generating circuit comprising:

a first delay circuit which delays an input signal input to a first input terminal;

a second delay circuit which delays a complementary input signal input to a second input terminal;

a first pull-down circuit which is connected between a first output terminal and a ground voltage and pulls down a level of the first output terminal to the level of the ground voltage in response to an output signal of the first delay circuit;

a first pull-up circuit which is connected between a power supply voltage and the first output terminal and pulls up a level of the first output terminal to the level of the power supply voltage in response to the complementary input signal;

a second pull-down circuit which is connected between a second output terminal and the ground voltage and pulls down a level of the second output terminal to the level of the ground voltage in response to an output signal of the second delay circuit; and

a second pull-up circuit which is connected between the second output terminal and the power supply voltage and pulls up a level of the second output terminal to the level of the power supply voltage in response to the input signal.

9. (Original) The circuit as claimed in claim 8, wherein the output signals of the first and second output terminals are differential signals.

10. (Original) The circuit as claimed in claim 8, wherein the first and second delay circuits are inverters.

11. (Original) A charge pump comprising:

a first output terminal;

a second output terminal;

a first current source coupled to a power supply voltage;

a second current source coupled to the power supply voltage;

a first current sink coupled to a ground voltage;

a second current sink coupled to the ground voltage;

first differential switches which are connected between the first output terminal and the first current source and respond to first differential switching control signals;

second differential switches which are connected between the second output terminal and the first current sink and respond to second differential switching control signals;

third differential switches which are coupled to the second output terminal and the second current source and respond to the first differential switching control signals; and

fourth differential switches which are connected between the second output terminal and the second current sink and respond to the second differential switching control signals.

12. (Original) The charge pump as claimed in claim 11, wherein the output signals of the first and second output terminals are differential signals or complementary signals.

13. (Original) The charge pump as claimed in claim 11, wherein the first current source, the second current source, the first current sink, and the second current sink have the same current values.

14. (Original) The charge pump as claimed in claim 11, further comprising a first switching control signal generating circuit for generating the first differential switching control signals, which includes:

a pair of input terminals;

a pair of output terminals; and

a conversion circuit which converts differential signals input via the pair of input terminals into the first differential switching control signals and outputs the first differential switching control signals to the pair of output terminals, respectively,

wherein based on a state of each of the differential signals input via the pair of input terminals, the conversion circuit makes a first one of the first differential switching control signals having a relatively high level and a second one of the first differential switching control signals having a relatively low level transition to the level of the second signal and the level of the first signal, respectively, at different time points.

15. (Previously Presented) The charge pump as claimed in claim 14, further comprising a second switching control signal generating circuit for generating the second differential switching control signals, which includes:

a pair of input terminals;

a pair of output terminals;

a conversion circuit which converts differential signals input via the pair of input terminals into the second differential switching control signals and outputs the second differential switching control signals to the pair of output terminals, respectively,

wherein based on a state of each of the differential signals input via the pair of input terminals, the conversion circuit makes a first one of the second differential switching control signals having a relatively high level and a second one of the second differential switching control signals having a relatively low level transition to the level of the second signal and the level of the first signal, respectively, at different time points.

16. (Original) The charge pump as claimed in claim 11, further comprising a common mode feedback circuit which is coupled to the first output terminal and the second output terminal and holds a common voltage of the output signal of the first output terminal and the output signal of the second output terminal to a constant value.

17. (Previously Presented) A charge pump comprising:

a first input terminal;

a second input terminal;

a third input terminal;

a fourth input terminal;

a first output terminal;

a second output terminal;

a switching control signal generating circuit providing first differential signals to at least one of the first and second input terminals and second differential signals to at least one of the third and fourth input terminals;

a pumping circuit which charges the first output terminal to a first voltage and simultaneously discharges the second output terminal into a second voltage in response to the first differential signals input to the first and second input terminals, or charges the second output terminal to the first voltage and simultaneously discharges the first output terminal into the second voltage in response to the second differential signals input to the third and fourth input terminals; and

a common mode feedback circuit which is coupled to the first and second output terminals and holds a common voltage of output voltages of the first and second output terminals to a given value,

wherein the output voltage of the first output terminal and the output voltage of the second output terminal are differential signals.

18. (Original) A phase locked loop including the charge pump as claimed in claim 17, comprising:

a phase-frequency detecting circuit which outputs the first differential signals and the second differential signals; and

a voltage controlled oscillator which generates an output clock signal in response to a difference between the output voltage of the first output terminal and the output voltage of the second output terminal,

wherein the phase-frequency detecting circuit outputs the first differential signals and the second differential signals in response to a reference clock signal and the output clock signal.

19. (Original) The phase locked loop as claimed in claim 18, wherein the voltage controlled oscillator includes:

a voltage-current converter which generates current corresponding to the difference between the output voltage of the first output terminal and the output voltage of the second output terminal; and

a vibrator which generates the output clock signal in response to the output signal of the voltage-current converter.

20. (Original) The phase locked loop as claimed in claim 18, wherein when the phase locked loop further includes a frequency divider to divide the output clock signal output from the voltage controlled oscillator, the phase-frequency detecting circuit outputs the first differential signals and the second differential signals in response to the reference clock signal and the output clock signal output from the frequency divider.

21. (Original) A switching control signal generating circuit comprising:

input terminals, wherein said input terminals carry a plurality of input signals;

output terminals, wherein said output terminals carry a plurality of output signals; and

a conversion circuit which converts a plurality of the input signals into a plurality of output signals, wherein the output signals are differential switching control signals having a plurality of levels of voltage transition, and

where the differential switching signals transition from one level to another level at different times.

22. (Original) The generating circuit of claim 21, wherein the conversion circuit further comprises:

a first delaying circuit, wherein the first delaying circuit delays a first input signal and generates a first output signal using the first input signal;

a second delaying circuit, wherein the second delaying circuit delays a second input signal and generates a second output signal using the second input signal;

a first transition circuit, wherein the first transition circuit transitions the first output signal between a first and second level; and

a second transition circuit, wherein the second transition circuit transitions the second output signal between the first and second level, wherein the transitions of the first and second transition circuits result in temporally shifted first and second output signals.

23. (Original) A method of generating switching control signals comprising:

inserting input signals; and

converting the input signals to a plurality of output signals, wherein a plurality of the output signals are differential switching control signals transitioning from a plurality of voltage levels, where each of the differential switching control signals are temporally shifted as a result of the step of converting, and where the temporal shift in the differential switching control signals are used to reduce at least one of glitch and jitter in secondary signals.

24. (Original) The method of claim 23, wherein the step of converting further comprises:

delaying a first input signal and generating a first output signal using the first input signal;

delaying a second input signal and generating a second output signal using the second input signal;

first transitioning the first output signal between a first and second level; and

second transitioning the second output signal between the first and second level, wherein the first transitioning and the second transitioning occur at different times.

25. (Previously Presented) A method of charge pumping comprising:

inserting input signals into a switching control signal generating circuit, wherein the switching control signal generating circuit produces first and second differential switching control signals, wherein the first and second differential switching control signals are temporally shifted with respect to each other; and

charging a first output terminal to a first voltage and simultaneously discharging a second output terminal into a second voltage in response to the first differential switching control signal, or charging the second output terminal to the first voltage and simultaneously discharging the first output terminal into the second voltage in response to the second differential switching control signal.

26. (Previously Presented) A charge pump, comprising:

a switching control signal generating circuit including input terminals for receiving a plurality of input signals, output terminals for outputting a plurality of output signals and a conversion circuit for converting the plurality of the input signals into the plurality of output signals, wherein the output signals are differential switching control signals having one of a first and second voltage level and the differential switching control signals transition between the first and second voltage levels; and a charge pump unit including a first output terminal and a second output terminal, the charge pump unit receiving the differential switching control signals and setting at least one of the first and second output terminals to one of the first and second voltage levels based at least in part on the received differential switching control signals.

27. (Previously Presented) The charge pump of claim 26, wherein the first voltage level is higher than the second voltage level.

28. (Previously Presented) The charge pump of claim 26, wherein the first voltage level is lower than the second voltage level.

29. (Previously Presented) A phase locked loop including the charge pump as claimed in claim 26, comprising:

a phase-frequency detecting circuit which outputs first differential signals and second differential signals, the switching control signal generating circuit receiving the first and second differential signals and converting the received first and second differential signals into the differential switching control signals; and

a voltage controlled oscillator which generates an output clock signal in response to a difference between the output voltage of the first output terminal and the output voltage of the second output terminal,

wherein the phase-frequency detecting circuit outputs the first differential signals and the second differential signals in response to a reference clock signal and the output clock signal.